— CHALLENGES IN ASSESSING THE ECONOMIC IMPACT OF UNIVERSITIES

SOME REFLECTIONS ON INDICATORS, DATA AND PATHWAYS TO MEASURE INNOVATION

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23.11.2016

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WHAT YOU WILL HEAR ABOUT TODAY:

01 University missions nowadays
02 Indicators used in university rankings
03 In search of economic impact indicators
04 Pathways to economic impact
05 Technology transfer and commercialization
06 What publication and patent based indicators tell us
07 Examples and inspirations

BROAD MISSIONS OF A UNIVERSITY: KEY ACTIVITIES

RANKINGS AND DEVELOPMENTS OF NEW INDICATORS

- Data and number of indicators experience a rapid growth

universidades españolas según campos y disciplinas científicas

NEW DEVELOPMENTS IN RANKINGS: A CLOSER LOOK AT INNOVATION AND ECONOMIC IMPACT

REUTERS

TOP 100

THE WORLD'S MOST INNOVATIVE UNIVERSITIES

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The Top 25 Global Innovators:

Government

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REUTERS

TOP 75

ASIA'S MOST INNOVATIVE UNIVERSITIES 2016

KEY INDICATORS IN UNIVERSITY RANKINGS

- Quality of education (alumni successes, awards, recognitions)
- Quality of faculty (reputation, awards, medals)
- Research Output (publications, citations, comparison)
- Employer reputation
- Student-to-facutly ratio
- International faculty and students ratios

-Patents and all things related
-Industry income
-Industry partners
-Commercialization
-Graduates in industry leadership roles
-Spin-offs
-New infrastructures

PATENTS BASED INDICATORS

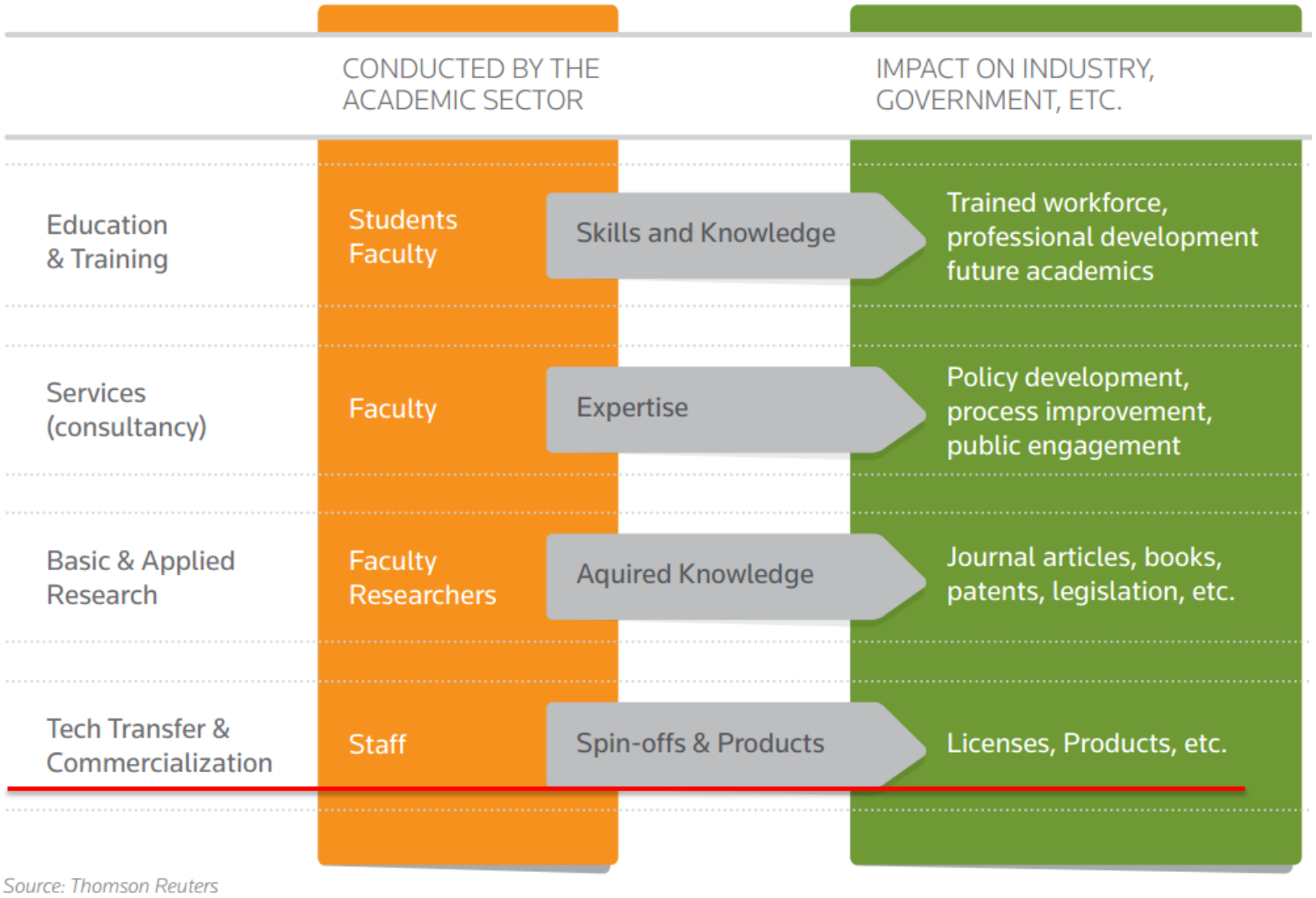
- What can be measured:
  - Patent volume (filed to and registered with WIPO)
  - Patent success (the ratio # applications/accepted patents)
  - Global patents (for US, Europe, Japan PO)
  - Patent citations (by other patents)
  - Patent citation impact, Percent of patents cited
  - Patent to article citation impact; Industry article citation impact
  - Percent of industry collaborative articles

Measuring economic impact ...

„Universities are being viewed as economic engines that convert public funding into knowledge, scholarship and products with an economic impact as a by-product of this engine's activity"

E. Stephan, How economics shapes science
Harvard University Press, 2012

BROAD MISSIONS OF UNIVERSITIES LEAD TO DIVERSE IMPACTS



Source: Thomson Reuters

Source:
http://stateofinnovation.thomsonreuters.com/measuring-innovation-knowledge-transfer-and-economic-impact

MEASURING ECONOMIC IMPACT AND INNOVATION: SOME KNOWN TRUTHS

- INDICATORS to measure economic impact are available but they are not well developed for systematic institutional comparisons
- TIME is an issue: it can take decades from initial investment to a visible and measurable economic impact
- DATA: third parties can collect data and measure economic impact independently of the university involved in research and investment
- PATENT applications' high quantity ≠ high economic impact
- INDUSTRY dependent: data varies depending on the industrial sector involved
- INSTITUTIONS may have impact on companies they do not collaborate with

POTENTIAL INDICATORS OF ECONOMIC IMPACT

- Education and training activities:
  - Graduate employment rates
  - Average graduate salaries (after x number of years)
  - Value and size of professional training programs
  - Number of courses accredited / recognized by professional bodies
  - Entrepreneurship courses (enrollment, industry engagement)
  - Value of industry-funded scholarships
  - Values of other contributions from industry
  - Alumni in executive roles in industry or professional societies etc

POTENTIAL INDICATORS OF ECONOMIC IMPACT

- Basic and applied research:
  - Value of reseach contracts from industry
  - Number of research contracts from industry
  - Number of publications with acknowledgements of industry funding
  - Number and proportion of papers co-authored with industry
  - Volume of citation of such publications
  - Patent applications
  - Proportion of patent applications that were granted

POTENTIAL INDICATORS OF ECONOMIC IMPACT

- Technology transfer and commercialization:
  - Number of staff in TTO
  - Number of disclosures, IP licenses
  - Value of IP income
  - Number of active patents
  - Venture capital investment in spin-off companies
  - Number of spin-off companies
  - Value of sale of shares of spin-offs
  - Proportion of spin-off companies still in operation after 5 years
  - Revenue of spin off companies after 5 years

POTENTIAL INDICATORS OF ECONOMIC IMPACT

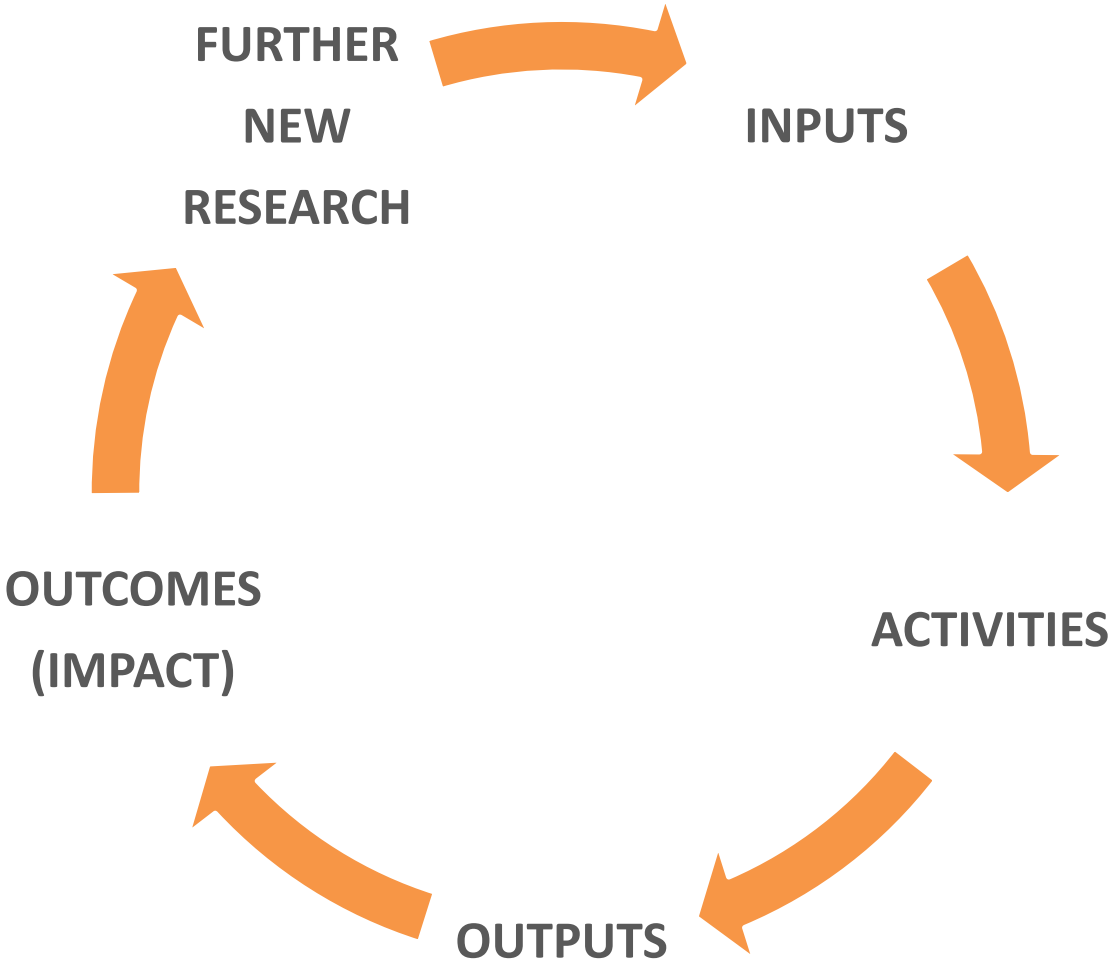
- Consultancy services by faculty and secondary impact in practice
  - Number of contracts or engagements
  - Value of this revenue
  - Number of facutly on advisory boards, management boards
  - Co-authorship, citation or news mention in various sources (acts of parliament, changes of statutes, changes in regulations, standards, legislation, policy recommendations)
  - Authorship of new datasets or other resources that facilitate improvements to business processes

THE PATHWAYS TO ECONOMIC IMPACT

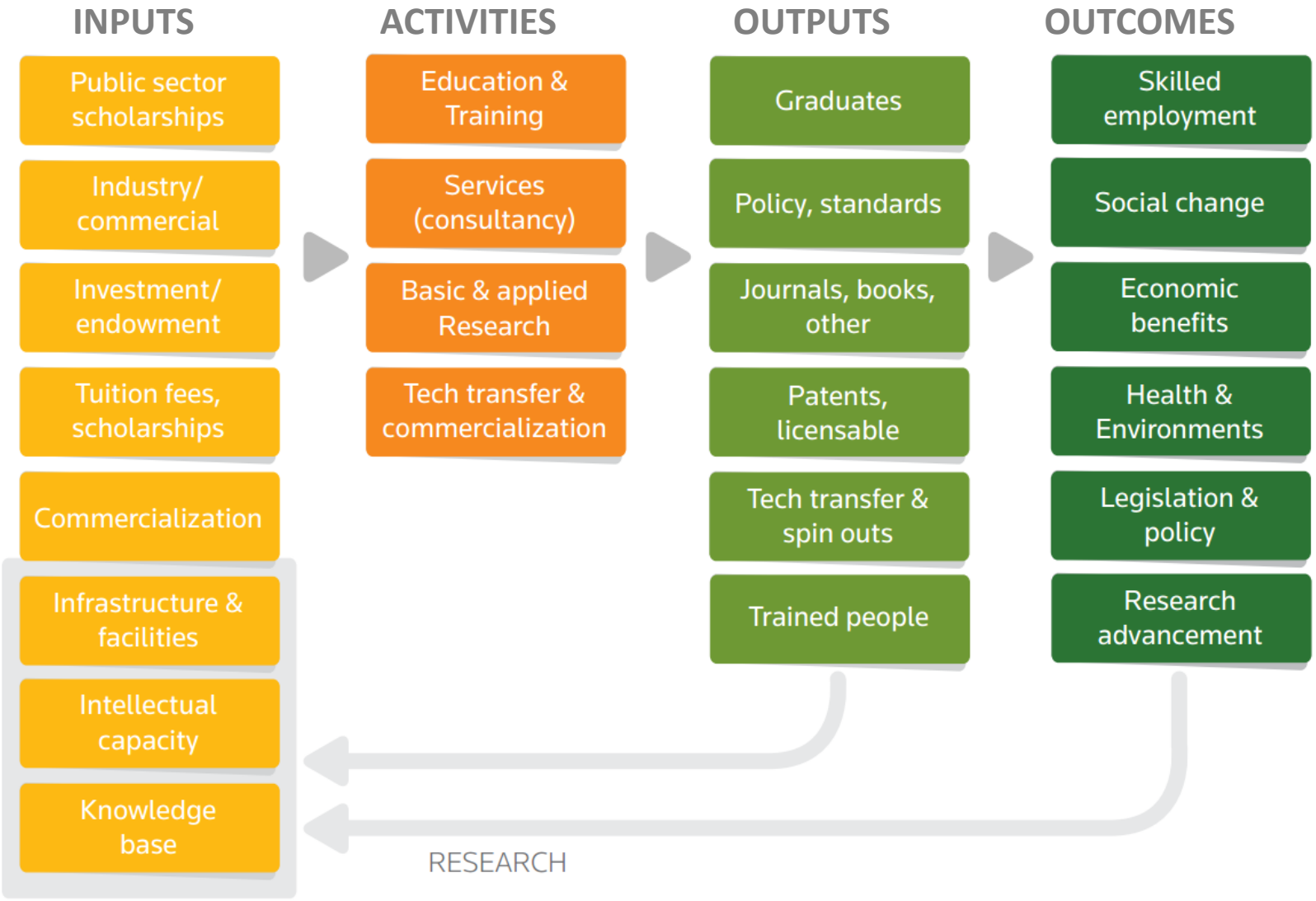
INPUTS at universities are very diverse:

- Public sector scholarships
- Industry/commercial research contracts
- Investments/endowment
- Tuition fees, scholarships
- Commercialization of research
- Infrastructure and facilities
- Intellectual capacity
- Knowledge base

THE PATHWAYS TO ECONOMIC IMPACT: A SIMPLE CYCLE ?



THE PATHWAYS OF R&D IMPACTS



Source: Thomson Reuters

THE PATHWAYS TO ECONOMIC IMPACT

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OTC, ORC, OIP, TCO, RSO – OFFICE OF TECHNOLOGY COMMERCIALIZATION

Georgetown University
OTC
Partners in Innovation

UNIVERSITY OF CAMBRIDGE
Study at Cambridge
/ Impact / Routes to impact
Research Strategy Office

UNIVERSITY OF MINNESOTA
Driven to Discover℠
OVPR Home | For Researchers & Staff | For Business & Partners
Office for Technology Commercialization

Drexel UNIVERSITY
OFFICE OF TECHNOLOGY COMMERCIALIZATION

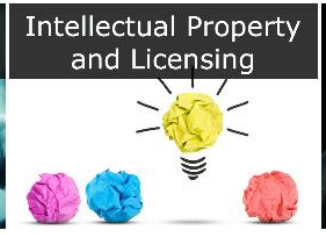
The University of Texas at Austin
Office of Technology Commercialization
Office of the Vice President for Research

The Office of Technology Commercialization is responsible for the protection and efficient transfer of university discoveries to the marketplace for the benefit of society.

Office of Research Commercialization (ORC)

Mission and Units

ORC is dedicated to transforming research at Rutgers into products, services and partnerships for the public good, generating value for the University and enhancing economic development in the State of New Jersey.



THE OHIO STATE UNIVERSITY
Technology Commercialization Office

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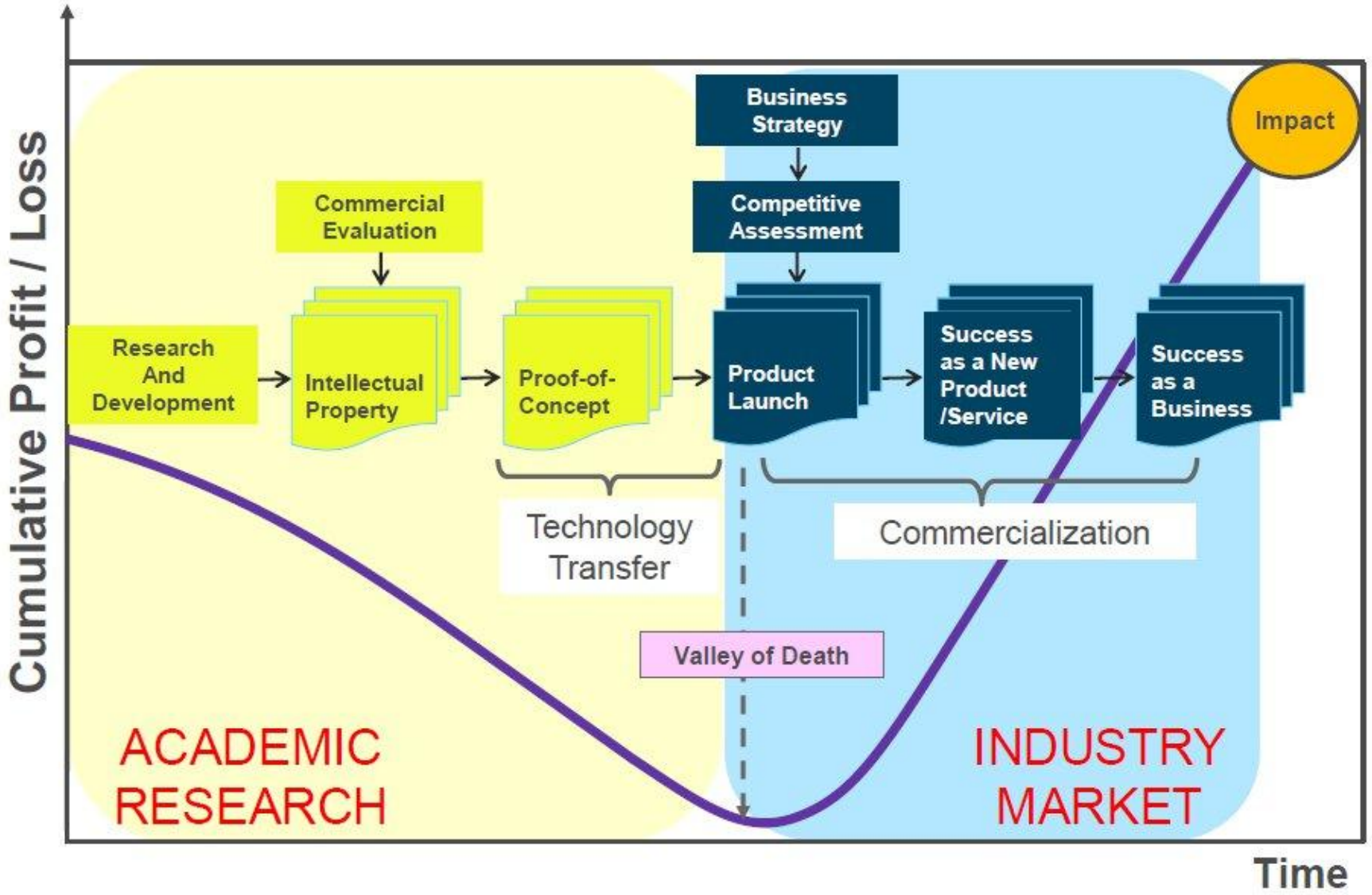
TRANSLATING BASIC RESEARCH TO PRACTICAL APPLICATION



SOURCES OF MAJOR CHALLENGES IN INDUSTRY-UNIVERSITY COLLABORATION

- Are academia and industry worlds' apart?
- How to build these cross-sector partnership?
- Have you considered enumerating mutual benefits?

WHAT PUBLICATION BASED INDICATORS CAN TELL US

INDICATOR	ACTIVITY	DESCRIPTION
% Articles co-authored with industry	Output / Outcome	The volume articles that contain one or more co-authors from a commercial entity. This indicator shows the volume of research activity that is conducted in collaboration with industry and it is an indicator of potential future economic impact.
Citations affiliated with industry per article	Outcome	Article to article citations are an established indicator of influence and research impact. By limiting the citing items only to those items that are affiliated with industry it becomes an indicator of the influence and impact that basic research conducted in an academic setting has had on commercial research.
% Articles acknowledging funding from industry	Input	An indication of commercial sector investment. Although the articles themselves are a research output, the funding acknowledgment is an indication of research funding and is therefore an input measure.
Patent citations per article	Outcome	Similar to “Patent citations per patent” this indicator measures the average number of times an article has been cited by patents. This unique indicator is an indication that basic research conducted in an academic setting (as measured by articles) has had influence and impact upon commercial Research & Development (as measured by patents).

WHAT PATENT-BASED INDICATORS CAN TELL US

INDICATOR	ACTIVITY	DESCRIPTION
Number of patents	Output	The number of basic patents filed by the organization is an indication of research output with potential for commercial value.
Granted patents per application	Outcome	The proportion of patent applications that are granted shows the success rate in the patent filing process and indicates the significance of the inventions.
Patent global diversity	Outcome	The proportion of patents that have been filed in a second major country is a measure of the globally diversity of the patent portfolio. Filing a patent is an expensive and laborious process and filing in multiple countries is an indication that the invention is non-trivial and has commercial value.
Patent citations per patent	Outcome	This indicator measures the average number of times a patent family has been cited by other patents. As part of the patent inspection process the patent examiner will cite significant prior art. The number of times a patent has been cited is an indication that it has had impact on further R&D.
% patents cited one or more times	Outcome	This indicator is the proportion of papers that have been cited by other patents one or more times. It is a complementary indicator to the “Patent citations per patent” indicator

TOP US UNIVERSITIES RESULTS

Organization Name	Number of patents	Granted patents per application	Patent global diversity	Patent citations per patent	% patents cited one or more times	Patent citations per article	% Articles co-authored with industry	Citations affiliated with industry per article	% Articles containing acknowl-edgement of funding from industry
University of California System	2,796	49.3%	29.1%	2.34	53.6%	0.069	2.70%	0.465	10.1%
United States Navy	1,720	90.2%	5.5%	1.21	45.3%	0.039	1.28%	0.162	1.3%
Massachusetts Institute of Technology	1,357	58.1%	21.4%	2.86	63.2%	0.161	4.20%	0.752	8.1%
University of Texas System	1,144	51.3%	28.3%	1.93	57.3%	0.087	2.90%	0.441	12.9%
Stanford University	1,032	66.5%	23.2%	2.56	59.6%	0.096	3.83%	0.595	12.6%
United States Department of Energy	890	75.7%	14.6%	1.52	46.9%	0.057	2.59%	0.301	2.4%
State University of New York System	891	55.7%	21.4%	1.51	46.9%	0.037	1.94%	0.288	12.0%
State University System of Florida	825	50.7%	21.3%	1.64	49.5%	0.045	1.73%	0.230	6.9%
United States Army	791	88.0%	5.7%	1.28	46.0%	0.053	2.00%	0.194	2.4%
California Institute of Technology	766	71.1%	24.3%	2.96	62.1%	0.066	1.86%	0.269	3.6%

"It is clear that university leadership matters in technology transfer, both in setting the approach and tone within universities but also in the national push for development. Different leaders define different missions for their universities, reflecting different institutional capabilities. This will make simple comparisons between universities that are based on single outputs, (for example, number of spin-out companies formed) difficult, meaningless and negatively misleading. University vice-chancellors in the UK are fully committed to delivering on the Government's economic priorities, but we will each contribute differently.'

Professor Trevor McMillan, Vice-Chancellor of Keele University

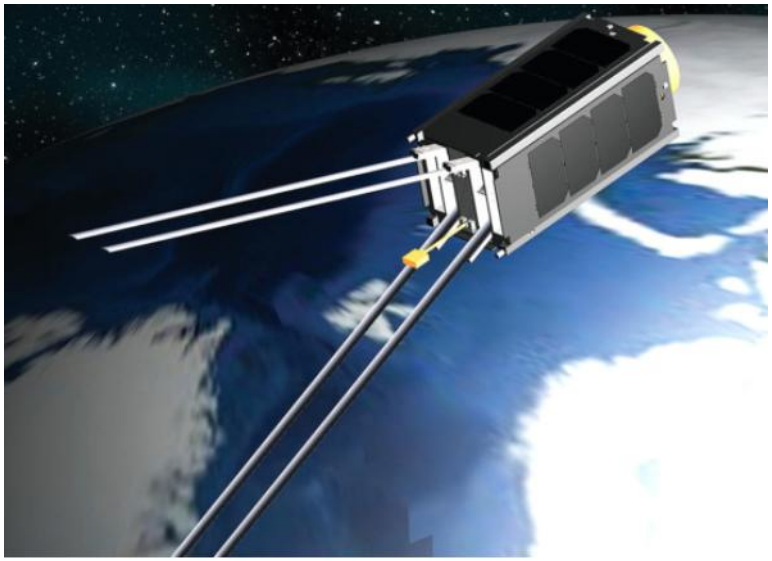
http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/University,KE,framework,Good,practice,in,technology,transfer/2016_ketech.pdf

SUPER IDEA SUPPORTED BY GREAT INVESTORS

Detecting sub-sea hydro-carbons: MTEM Ltd:

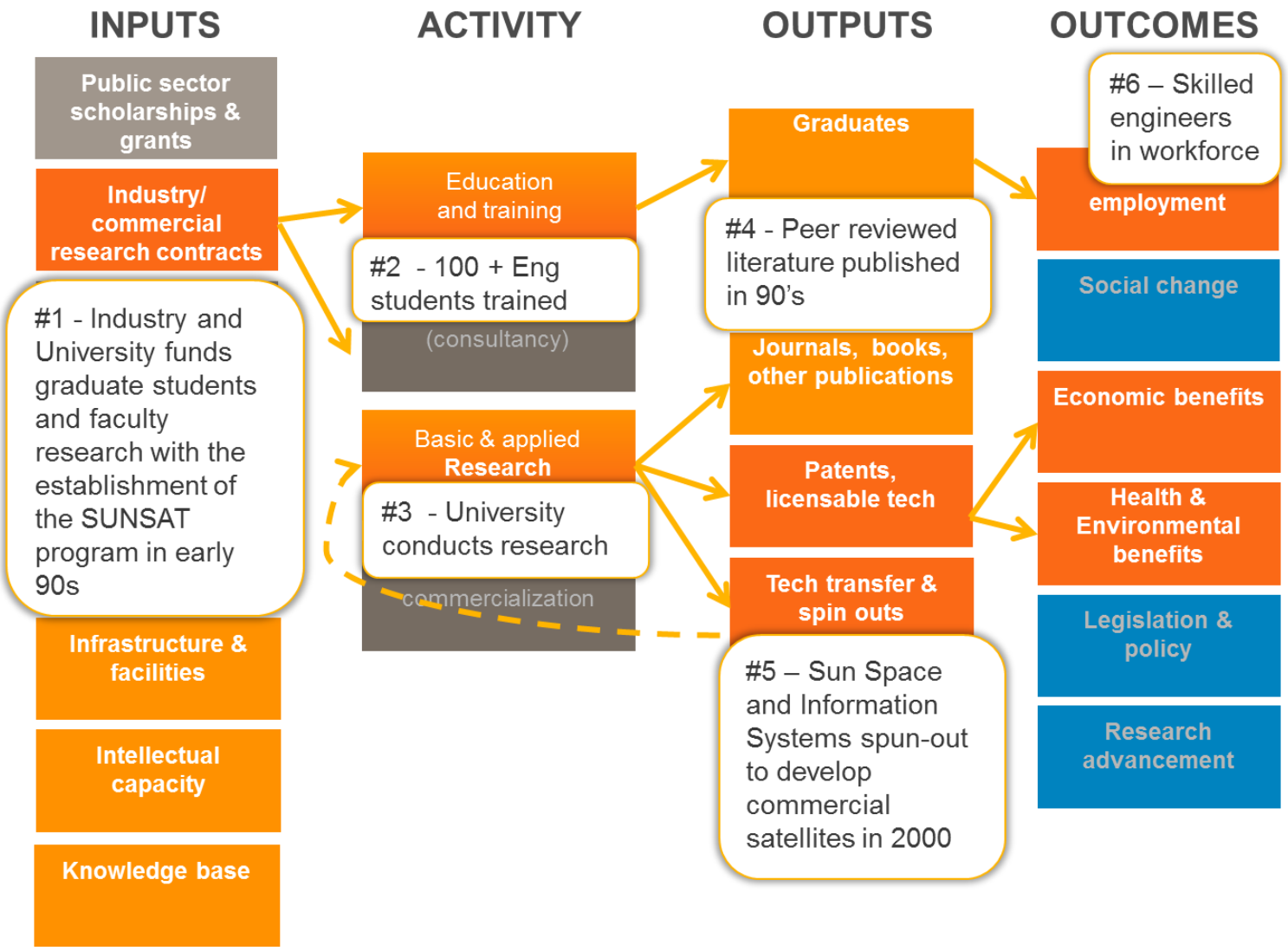
- In 2001 researchers in University of Edinburgh's School of GeoSciences developed a new electromagnetic method to detect sub-sea and underground hydrocarbons.
- In November 2004 MTEM Ltd was launched from the University of Edinburgh with £7.4 million of funding from three equal investors: HitecVision, Energy Ventures, and Scottish Equity Partners.
- After completing the first commercial marine survey in the North Sea, Petroleum Geo-Services (PGS) bought MTEM Ltd. for $275m.
- PGS then established a Strategic Alliance with the University leading to £1.1m in research funding.

STELLENBOSCH UNIVERSITY, SOUTH AFRICA SATTELITE PROGRAM



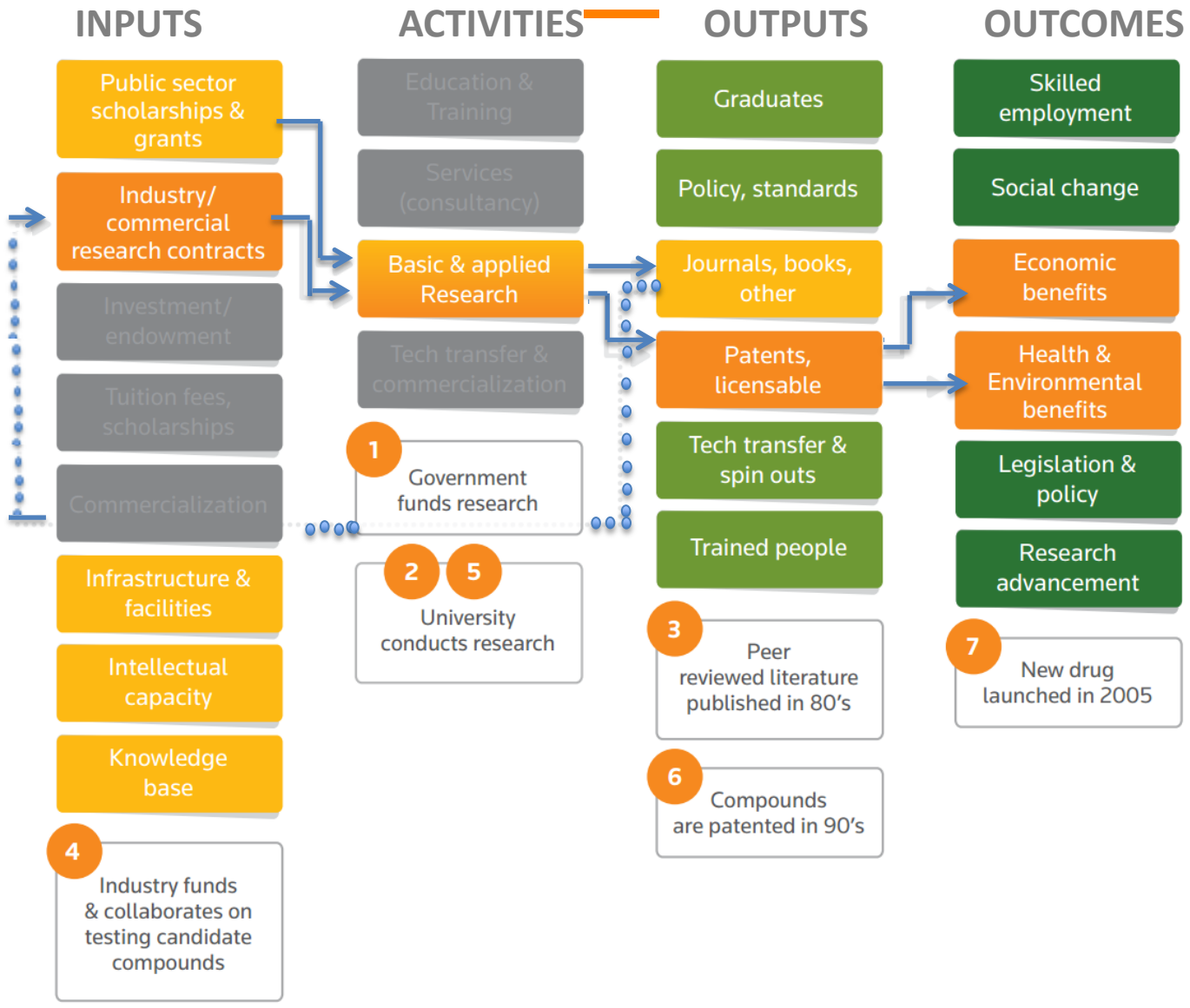
- The **S**tellenbosch **UN**iversity **SAT**ellite is the first miniaturized satellite designed and manufactured in South Africa. It was launched aboard a Delta II rocket from the Vandenberg Air Force Base on 23 February 1999. Sunsat was built by post-graduate engineering students at the University of Stellenbosch. Its AMSAT designation was SO-35 (Sunsat Oscar 35).

LAUNCHING SOUTH AFRICA'S MICRO-SATELLITE RESEARCH INDUSTRY WITH SUNSAT



THE PATH TO A BLOCKBUSTER DRUG: NORTHWESTERN UNIVERSITY, IL, USA

THE PATH TO A BLOCKBUSTER DRUG



Source: Thomson Reuters

SELECT CRITERIA FOR INDICATORS OF ECONOMIC IMPACT

- ***Is the indicator size-independent?*** Due to the variations in the size of universities in terms of faculty, students, research activities or support for commercialization, it is important that indicators reflect the performance of the university in a size-independent way.
- ***Is the indicator direct, or indirect?*** Indicators should be used that reflect both the direct economic impact, as well as the indirect benefits universities may have on local, regional and national economies.
- ***Is the indicator sufficiently timely to tell us something about the university's recent impact?*** The influence of universities on downstream economic activity may take significant time to accrue and therefore it is important to consider how timely each indicator may be.
- ***Is a meaningful and relevant baseline available for this indicator?*** Interpretation of indicators and their subsequent value in rankings are enhanced by relating a discrete value to a relevant baseline. Common baselines include location-based or global averages, disciplinary averages, or institutional classification averages (e.g. Carnegie Classification of Institutions of Higher Education).

ASSESSMENT OF PUBLICATION-BASED INDICATORS

INDICATOR	SIZE-DEPENDENCY	DIRECTNESS	TIMELINESS	BASELINE
% Articles co-authored with industry	Normalized to total number of articles	Indirect	Current – same as existing publication-based indicators	Possible
% Citations affiliated with industry per article	Normalized to total number of citations	Indirect	Moderate to slow – requires time for article to be incorporated into industry research	Possible
% Articles containing acknowledgement of funding from industry	Normalized to total number of articles	Indirect	Current – same as existing publication-based indicators	Possible
Patent citations per article	Normalized to total number of articles	Indirect	Slow – requires time for article to be incorporated into industry research and patent application process	Possible

ASSESSMENT OF PATENT-BASED INDICATORS

INDICATOR	SIZE-DEPENDENCY	DIRECTNESS	TIMELINESS	BASELINE
Number of patents	Size-dependent	Indirect	Moderate – it takes time to prepare patent application	Possible
Granted patents per application	Normalized to the number of patents applied	Indirect	Moderate – the patent evaluation process takes years at most authorities	Possible
Patent global diversity	Normalized to the number of patents	Indirect	Moderate to slow – patent filings in multiple jurisdiction may take years	Possible
Patent citations per patent	Normalized to number of patents	Indirect	Moderate to slow – patents take some time to accrue patent citations	Possible
% patents cited one or more times	Normalized to number of patents	Indirect	Moderate to slow – patents take some time to accrue patent citations	Possible

WHERE IS DATA COMING FROM?

- Data on scholarly publications and citations were sourced from Clarivate Analytics (formerly IP & S Thomson Reuters) InCites™, which is the gold standard for bibliometric evaluation and built on Web of Science citation index. http://researchanalytics.thomsonreuters.com/incites/

- Patent data were sourced from Derwent World Patents Index (DWPI), which is the world's largest and most authoritative database of patents. The Patent Citation Index was also used which is a complementary database of patent citations. http://ip.thomsonreuters.com/product/derwent-world-patents-index

"There are many common preconceptions around challenges in accessing university intellectual property. Our experience in working with industry paints a different picture and, hopefully, this paper will reassure the technology community that we take on board feedback and common ground can be found.„

UK University Technology Transfer : Behind the Headlines

Claire Brady, Head of Technology Transfer at Edinburgh Research and Innovation, the Commercialization office for the University of Edinburgh

HAVE YOU HEARD OF UT AUSTIN 8 STEPS OF COMMERCIALIZATION?

OTHER EXAMPLES OF UNIVERSITY COLLABORATION WITH COMMERCIAL ENTITIES

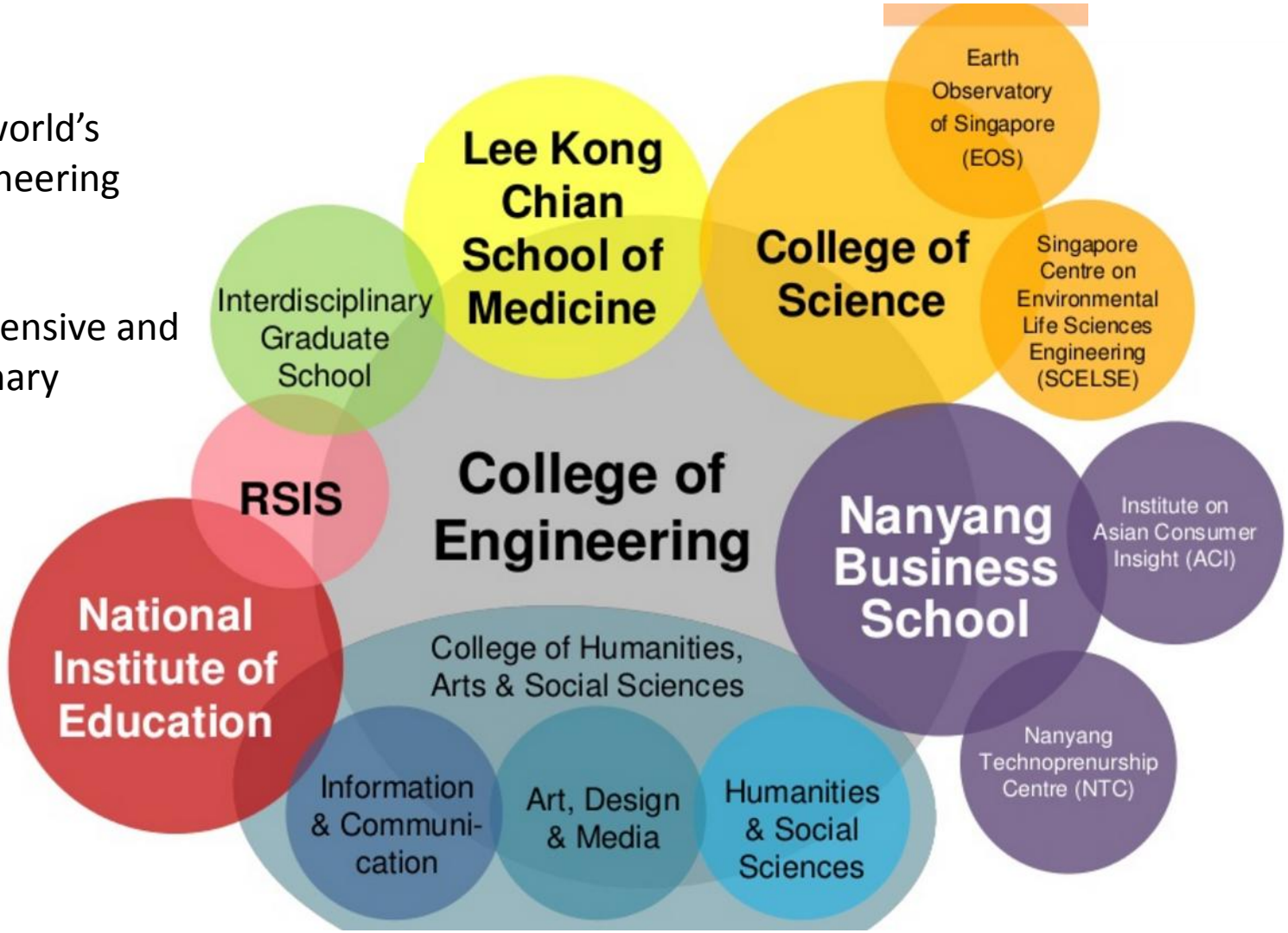
Nanyang Technological University (NTU), Singapore

1955: Funded and Nanyang Univeristy (1955-1979)
1981: Nanyang Technological Institute established
1991: Established as Nanyang Technological University
Focus: engineering and business till 2001
2001: New schools added (i.e. Biological Sciences, Humanities, Social Siences , Physical and Mathematical Sciences, Medicine, Art, Design & Media)

NANYANG TECHNOLOGICAL UNIVERSITY (NTU), SINGAPORE

One of the world's biggest engineering college

Research-intensive and interdisciplinary



http://www.slideshare.net/StateOfInnovation/2016-innovation-forum-presenter-slides from Prof. Michael Khor's presentation on NTU (30-59)

NTU'S ALLIANCES WITH FOREIGN UNIVERSITIES

http://www.slideshare.net/StateOfInnovation/2016-innovation-forum-presenter-slides om Prof. Michael Khor's presentation on NTU (30-59)

NTU'S MAJOR INTERNATIONAL INDUSTRY PARTNERS

http://www.slideshare.net/StateOfInnovation/2016-innovation-forum-presenter-slides om Prof. Michael Khor's presentation on NTU (30-59)

THANK YOU !!!

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